Demographic Fluctuations and the Pattern of Economic Development in Prussia, 1816-1873

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The role of the population variable within the context of the pattern of German economic development in the 19th century has never been effectively analysed or defined. Lösch, writing in the 1930's, could refer to changes in population growth rates as being among "... the main causes of economic changes"[1]. On the other hand more recent research would seem to confirm the general hypothesis that population growth was dependent on the overall process of socioeconomic development. Essentially there is still an important division between those who favour a narrowly Malthusian explanation, emphasising the interrelated dependence of population growth on underlying economic expansion, and those protagonists who argue that an alternative interpretation stressing the exogenous function of the demographic variable fits more closely the historical evidence. Indeed the endogenous explanation has its origins in the writings of such German neo-Malthusians as Weinheld[2], who posited a positive correlation between population growth and nascent industrialisation. More recently a number of German academics, including Ipsen, Köllmann and von Nell[3] have located the causative mechanism of 19th century population growth in the process of institutional agrarian reform, embodied particularly in the Prussian legislation of 1807 and 1811. However, it is important to note that this explanation, although widely accepted, has not gone completely un-challenged and the exogeneity of population growth within the context of 19th century Germany has been strongly argued in a number of recent publications[4].

The purpose of this present paper is to examine the nature of the registered demographic fluctuations in Prussia within the time period 1816 to 1873, in terms of the rate of growth of

1 Lösch, August, *Population Cycles as a Cause of Business Cycles*, in: Quarterly Journal of Economics, LI (1937), p. 649.

2 Weinheld, C. A., *Über die Population und die Industrie oder kritischer Beweis, daß die Bevölkerung in hochkultivierten Ländern den Gewerbefleiß stets übereile*, Leipzig 1828.

3 Ipsen, Gunther, *Die preußische Bauernbefreiung als Landesausbau*, in: Zeitschrift für Agrargeschichte und Agrarsoziologie, 2 (1954), pp. 29 ff., Köllmann, Wolfgang, *Bevölkerung in der industriellen Revolution. Studien zur Bevölkerungsgeschichte Deutschlands*, Göttingen 1976. Nell, Adelheid v., *Die Entwicklung der generativen Strukturen bürgerlicher und bäuerlicher Familien von 1750 bis zur Gegenwart*, Diss. Bochum 1973.

4 Lee, William Robert, *Germany*, in: Ders. (Ed.), *European Demography and Economic Growth*, London 1979, pp. 144–195.

population and its effect on agriculture and the structure of primary sector production. Use will be made of available statistical material on population, primary sector input and output, and relevant price indices[5]. The analysis will examine not only Prussia, as an individual state, but on a disaggregated basis, the disparate provinces of East Prussia, the Rhineland and Saxony.

The paper is composed of four major and distinct sections:

(i). An analysis of the extent to which population growth affected the amount of agricultural land under cultivation and the structure of output.

(ii). A test for the endogeneity/exogeneity of population growth.

(iii). A preliminary examination of the relationship of population growth to population structure, designed to show the extent to which the age structure of the population is dependent in the long-term on the rate of growth of population.

(iv). The results obtained from this analysis will also be assessed in the context of the pattern and nature of economic development in Prussia and in the three disaggregated provinces within the time period 1816 to 1873. This will focus on a variety of factors relevant to the cyclical development of the economy (whether in terms of cycles "of the old type", or cycles associated with the growth of a capitalist economy). It is to be hoped, therefore, that this study will also serve as a contribution to the overall assessment of the role of the population variable and provide either confirmation or refutation of the existing opposing interpretations of this factor's importance in the general process of economic growth in 19th century Germany.

A. An Explanation of Mortality and Fertility Trends

The first intention of this study was to isolate the general trends of mortality and fertility in Prussia during the period under consideration. Population appears to grow at an overall rate of >1% per annum throughout the period 1818 to 1866. Indeed it is worth noting that this growth rate compares favourably with the average increase in population in Western Europe as a whole during the same period[6]. The following equation was fitted (the key to the variables used in all the following equations is to be found in the *notation, Appendix A*):

$$PP = Ae^{bt}$$

and estimated in its log linear form

$$\ln(PP)_t = \underset{(350)}{16.2} + \underset{(73.93)}{.0119\,t} \qquad (1)$$

$\bar{R}^2 = .99$; t = t-statistic

5 Fircks, Arthur Frhr. v., *Rückblick auf die Bewegung der Bevölkerung im preußischen Staate*, in: Preußische Statistik, 48 A, (1879). Finck v. Finckenstein, H. W. Graf, *Die Entwicklung der Landwirtschaft in Preußen und Deutschland und in den neun alten preußischen Provinzen von 1800–1930, Bern 1959. Jacobs, A., u. Richter, H., Die Großhandelspreise in Deutschland von 1792 bis 1934*, Vierteljahrshefte zur Konjunkturforschung, Sonderheft 37, Berlin 1935.

6 Armengaud, André, *Population in Europe, 1700–1914*, in: Cipolla, Carlo M., (Ed.), *The Fontana Economic History of Europe*, Bd. 3, London 1973, pp. 27–29.

It emerged that the birth and death rate are stationary. In order to discriminate between a fall in the death rate and a rise in the birth rate, and also to determine the effect of migration, the following equation was estimated for the period 1828 to 1874 for the Prussian state as a whole:

$$\Delta P_t = \underset{(-0.14)}{-.00023} + \sum_{i=1}^{8} V_i \Delta(TB/PP)_{t-i} + \sum_{i=1}^{8} k_i \Delta(TD/PP)_{t-i} \qquad (2)$$

$$\bar{R}^2 = .7959 \qquad \Sigma V_i = \underset{(4.00)}{4.07} \qquad \Sigma K_i = \underset{(4.2)}{-2.92} \qquad DW = .4$$

The results suggest that the rate of growth of population during this period was primarily attributable to an increase in the birth rate, rather than to a decrease in the death rate. The effects of migration appear to have been insignificant throughout the period under review. The results of this examination, however, ought to be viewed as preliminary, rather than conclusive.

B. Factor Productivity in the Prussian Primary Sector

Conventional economic theory suggests that for a given rate of growth of population, capital input has to increase if labour productivity is to remain constant, provided that the productivity of the new capital (land) remains the same[7]. Since the Prussian economy during the period under consideration grew at a faster rate than population growth, one would expect that the productivities of the factors of production would also rise. Increasing emphasis would also be given to land-saving techniques, since the supply of arable land was finite. In the case of Prussia the land input did in fact increase, but not as fast as population. Given a rate of growth for the economy, land productivity had to increase. For the period 1816 to 1873 ln land productivity in fact rose by .02 every three years, although there is evidence of some deceleration in the later years of the period under consideration. ln labour productivity, on the other hand, rose at a slower rate of .007 every three years during the same period, but accelerated noticeably during the latter part of the period. The results of the analysis are listed below:

$$\ln(Y/L)_t = \underset{(2.1)}{3.96} + \underset{(4.7)}{.02}\,t \qquad (3)$$

$$\bar{R}^2 = .91 \qquad DW = 1.2$$

$$\ln(Y/N)_t = \underset{(244.0)}{4.3} + \underset{(4.7)}{.007}\,t \qquad (4)$$

$$\bar{R}^2 = .541 \qquad DW = 1.2$$

7 Kuznets, Simon, *Population, Capital and Growth*, New York 1973, pp. 10–20.

C. An Analysis of the extent to which Population Growth affected the amount of Agricultural Land under cultivation and the Structure of Output

The necessity for the implementation of the land reforms of 1807 and 1811 in Prussia is solely attributed to economic pressures and political objectives, rather than to the impact of population pressure. Although the economic consequences of the land reforms have been subjected to the influence of the rate of growth of population, the theory that the rate of growth of population was subject to the economic consequences of the land reform appears to abstract from the economic needs inherent in the process of capitalist development in Prussia and from the specific property relations evident in a developing capitalist economy. The argument that the acceleration of population growth in the late 18th and early 19th centuries caused or initiated the process of land reform and therefore subsequent economic development appears to implicitly attribute Prussian economic growth to an external or non-controlable variable, rather than to the concrete economic needs inherent in the dominant mode of production.

The land reforms of 1807 and 1811, with their emphasis on a more rational system of land distribution and enforced land re-allocation, combined with the removal of all remaining feudal restrictions on production, provided the basis, it is argued, for the long-term commercial development of the Prussian primary sector. In addition fiscal and tariff policies in the early years of the 19th century also contributed to a further monetarisation of the economy and arguably provided the necessary signals for agricultural production to expand. This was achieved not only through an increase in the productivity of land, but also through a significant absolute increase in the amount of arable land under direct cultivation[8]. Furthermore this process implied a full utilisation of available land resourses, although the overall efficiency of the primary sector must remain somewhat in doubt, particularly when compared with other contemporary European economies (specifically the United Kingdom). Indeed certain observers, such as Lengerke[9], were not hesitant in emphasising the degree to which an optimal resource utilisation had not been achieved, particularly in the Eastern provinces of Prussia by the mid 19th century.

The effect of the rate of growth of population on the input of agricultural land and primary sector output, according to the present postulated hypothesis, ought to be insignificant[10]. However, a small positive influence is to be expected, given the fact that the rate of growth of population can be regarded as a proxy for an expanding aggregate demand. Land appears to have been the scarce factor throughout the period under consideration and land-saving techniques in agriculture were frequently employed. As a result the rate of growth of land productivity was invariably higher than the rate of growth of

8 Lee, *European Demography*, p. 153.

9 Lengerke, Alexander v., *Annalen der Landwirtschaft in den königlich Preußischen Staaten*, Berlin 1843, passim.

10 Reference was made in this section of the paper to the work of Dickler, Robert Alan, *Labor Market Pressure Aspects of Agricultural Growth in the Eastern Region of Prussia, 1840–1914: A Case Study of Economic – Demographic Interrelations during the Demographic Transition*. Ph. D. Diss., Pennsylvania: Pennsylvania State University 1975. See also Ders., *Organization and Change in Productivity in Eastern Prussia*, in: Parker, W.N., and Jones, E.L. (Eds.), *European Peasants and Their Markets*, Princeton, N.J., 1975, pp. 269–292.

labour productivity, at least until the latter part of this period. The following function was employed for the period 1816 to 1873 and applied in the case of East Prussia, the Rhineland and Saxony:

$$LL_{it} = a_0 + a_1 \Delta P_t + a_2 P_t + a_3 (Y/L)_t + a_4 (Y/N)_t + \varepsilon_t \qquad (5)$$

The expected signs are $a1 = 0$, $a2 > 0$, $a3 > 0$, $a4 < 0$ (or in terms of land/labour ratio (L/N) the expected coefficient on $a3$ is negative).

The necessary assumption for the signs are that relative prices adjust slowly, indicating a disequilibrium situation for the demand for land. As relative prices adjust, equilibrium is established. The more land-intensive a product tended to be, the more likely it became that a high land-labour ratio would have an adverse effect on its production, since given relative prices, it used more of the scarce factor than factors in relative abundance. The results of this analysis for the disaggregated regions of Prussia (East Prussia, the Rhineland and Saxony) are presented in *Table 1*.

The above estimated equations can be regarded as representing the supply for agricultural land allocated amongst different products in the separate provinces of East Prussia, the Rhineland and Saxony. In East Prussia the estimated coefficients and the appropriate signs for the rate of growth of population are always insignificant. Particularly in the long-term, the rate of growth of population in this specific case had no effect on the supply of land. In contrast agricultural prices and land productivity were both factors which contributed positively to the expansion in land supply. In the case of livestock fodder crops, which were considerably land intensive in relation to both grain crops and vegetable and commercial crops, land productivity appears negative for the reasons explained above. The results for Saxony on the basis of the calculated equations are also totally consistent with the postulated hypothesis.

In the case of the Rhineland, however, the coefficient of land productivity for grain appears with the wrong sign. It is important to note, however, that the series of output per acre (Y/L) and output per man (Y/N) are for the whole of the Prussian state and they do not therefore reflect regional differences between regions undergoing gradual industrialisation and provinces which were to remain almost totally agricultural in structure. This fact alone may explain the atypical result in this specific case.

Following the same line of argument, the supply of potatoes was also investigated. The increase in land productivity in this particular case is expected to have a positive sign, since the crop for the same calorific value appears to be less land intensive than either grain or livestock fodder crops. The following equation was estimated:

$$OUTPOT = \beta_0 + \beta_1 P + \beta_2 t + \beta_3 \Delta P + \beta_4 OUTGR + \beta_5 OUTPOT_{-1} + u_t \qquad (6)$$

The results are contained in *Table 2*, where total productivity has been approximated by a time trend and first order dynamic adjustment has been allowed as an approximation of stock adjustment.

The results, as expected, do not indicate any significant effect on the potato output of the rate of growth of population. The inclusion of the output of grain, it should be noted, is to determine whether or not these two crops were in fact competing for the same market. It appears from the analysis, however, that this was not the case. Potatoes were actually supplied independently of grain. This result would therefore seem to confirm the existing hypothesis, that the increasing cultivation of potatoes on more marginal land in the course

Table 1

EAST PRUSSIA (t statistics in brackets)

$$\ln(INLG) = \underset{(15.1)}{4.81} + \underset{(1.2)}{8.8}\Delta P + \underset{(.0008)}{.000001}P + \underset{(4.96)}{.034}\left(\frac{Y}{L}\right) - \underset{(-3.64)}{.034}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .95$ DW = 1.4

$$\ln(INLH) = \underset{(2.6)}{8.12} + \underset{(.5)}{31.1}\Delta P - \underset{(-.5)}{.007}P + \underset{(3.29)}{.19}\left(\frac{Y}{L}\right) - \underset{(-2.68)}{.2}\left(\frac{Y}{N}\right) - .19$$

$\bar{R}^2 = 86$ DW = 1.55

$$\ln(INLF) = \underset{(22)}{4.8} - \underset{(-.5)}{2.3}\Delta P + \underset{(.8)}{.0008}P - \underset{(-.04)}{.0001}\left(\frac{Y}{L}\right) - \underset{(-.5)}{.0028}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .18$ DW = 1.43

SAXONY

$$\ln(INLG) = \underset{(58.5)}{4.5} + \underset{(.27)}{.55}\Delta P + \underset{(1.44)}{.0006}P + \underset{(7.58)}{.0087}\left(\frac{Y}{L}\right) - \underset{(-4.5)}{.0074}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .9481$ DW = 1.09

$$\ln(INLH) = \underset{(5.05)}{9.5} - \underset{(-1.0)}{82.2}\Delta P + \underset{(1.26)}{.002}P + \underset{(5.01)}{.25}\left(\frac{Y}{L}\right) - \underset{(-3.7)}{.24}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .86$ DW = 1.52

$$\ln(INLF) = 4.96 - 2.41\Delta P - .00014 - .0177\left(\frac{Y}{L}\right) + .0142\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .44$ DW = 1.2

RHINELAND

$$\ln(INLG) = \underset{(1.79)}{4.65} + \underset{(.355)}{.458}\Delta P - \underset{(-1.60)}{.0024}P - \underset{(-8.16)}{.00258}\left(\frac{Y}{L}\right) + \underset{(3.72)}{.00204}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .9450$ DW = 1.5

$$\ln(INLH) = \underset{(5.29)}{5.259} - \underset{(-.27)}{12.6}\Delta P + \underset{(.48)}{.00288} + \underset{(7.78)}{.044}\left(\frac{Y}{L}\right) - \underset{(-4.34)}{.091}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .91$ DW = 1.14

$$\ln(INLF) = \underset{(58.5)}{4.58} + \underset{(.41)}{1.61}\Delta P - \underset{(-1.7)}{.0053}P - \underset{(-9.52)}{.009}\left(\frac{Y}{L}\right) - \underset{(5.1)}{.0085}\left(\frac{Y}{N}\right)$$

$\bar{R}^2 = .9960$ DW = 1.21

Table 2

(t statistics in brackets)

EAST PRUSSIA

$$OUTPOT = \underset{(-.05)}{-.754} + \underset{(.8)}{.18P} + \underset{(3.92)}{739t} + \underset{(.35)}{25163\Delta P_{-1}} + \underset{(.15)}{.03OUTGR} + \underset{(1.9)}{.53OUTPOT_{-1}}$$

$$\bar{R}^2 = .87 \qquad DW = 1.74$$

SAXONY

$$OUTPOT = \underset{(-.8)}{-747.1} + \underset{(.8)}{3.2P} + \underset{(.47)}{.104t} - \underset{(-.25)}{4983.1\Delta P_{-}} + \underset{(1.0)}{.41OUTGR} + \underset{(9.7)}{.89OUTPOT_{-1}}$$

$$\bar{R}^2 = .93 \qquad DW = 3.3$$

RHINELAND

$$OUTPOT = \underset{(.69)}{-685.1} + \underset{(1.0)}{5.3P} + \underset{(1.5)}{29.4t} - \underset{(-1.88)}{5242\Delta P_{-1}} + \underset{(2.34)}{.49OUTPOT_{-1}}$$

$$\bar{R}^2 = .83 \qquad DW = 2.6$$

of the early 19th century did not compete directly with grain production, particularly in the case of the eastern provinces of Prussian. However, contrary to the previous set of equations, the effect of agricultural prices appears to have been significant and always positive.

The extent to which the registered increase in population affected the structure of the supply of agricultural output via a change in the indigenous diet was also investigated. This was achieved by examining the movement of the output ratio of potatoes to grain and also by analysing the ratio of arable land utilised for the cultivation of vegetables and commercial crops to all agricultural land. The following equation was used; along the same lines of argument as *equation (5)*.

$$\ln \frac{(L_{it})}{L} = \gamma_0 + \gamma_1 P + \gamma_2 \Delta P + \gamma_3 (Y/L) + \gamma_4 (Y/N) + \varepsilon_t \qquad (7)$$

The results are contained in *Table 3*.

The most important influence on the structure of production appears to have been the increase in land productivity, which can probably be attributed to the implementation of agricultural land reforms and a more efficient use of elementary technology, rather than the registered increase in population, which appears negatively, but, as expected, insignificant at the 5% significance level. It can therefore be concluded that the redistribution and reallocation of agricultural land following the reforms of 1807 and 1811 was an important

Table 3

EAST PRUSSIA

$$\ln\left(\frac{INLH}{L}\right) = \underset{(.17)}{.023} - \underset{(-.56)}{2.18\Delta P} + \underset{(.347)}{.0113\left(\frac{Y}{L}\right)} - \underset{(-.2)}{.00108\left(\frac{Y}{N}\right)}$$

$$\bar{R}^2 = .3143 \qquad DW = 2.7$$

SAXONY

$$\ln\left(\frac{INLH}{L}\right) = \underset{(3.61)}{.77} - \underset{(-.51)}{2.88\Delta P} + \underset{(6.34)}{.0203\left(\frac{Y}{L}\right)} - \underset{(4.16)}{.211\left(\frac{Y}{N}\right)}$$

$$\bar{R}^2 = .911 \qquad DW = 1.4$$

RHINELAND

$$\ln\left(\frac{INLH}{L}\right) = \underset{(1.99)}{.46} - \underset{(-.24)}{2.82\Delta P} + \underset{(3.4)}{.001\left(\frac{Y}{L}\right)} + \underset{(3.41)}{-.0104\left(\frac{Y}{N}\right)}$$

$$\bar{R}^2 = .65 \qquad DW = 2.5$$

factor in influencing land productivity through facilitating the emergence of more efficient units of production.

D. An Examination of the Malthusian Theory of the Dependence of Population Growth on Economic Variables

The Malthusian theory of the overall dependence of population growth on economic variables was tested by regressing population growth in Prussia against agricultural output. The results were compared to those obtained previously (*Section A*) as a preliminary test for the exogeneity of population growth. The explanatory power of the equations, however,

was very small ($R^2 = .10-.33$) and none of the included output variables was significant. In order to take into account the increase in arable land, the land input was also included in the equation, but with no significant effect. The results obtained, therefore, do not indicate any explanatory power of relevant supply variables on the rate of growth of population. In view of this finding, together with the previously obtained results which attributed the increase in population in Prussia during the period under consideration to a rise in the birth rate, further research is clearly required into the social, economic and political conditions influencing fertility rates during this period.

E. An Examination of the Relationship of Population Growth to Population Structure

The implications of the registered growth in population in Prussia on the indigenous population structure appear to have been relatively straightforward. Appropriate theories in the demographic literature, as for example the one propounded by Lotka[11], have established the independence of the proportion of the population of age (x) from its actual size, and its dependence on the registered rate of growth. Data availability, however, was rather limited in respect of the age structure of population, but the following equation was estimated using pooled time series cross section data for EP – SX – RN:

$$\ln({}^{YG}/_{PP}) = \sigma_1 d_1 + \sigma_2 d_2 + \sigma_3 d_3 + \sigma_4 \ln(\Delta P) + \varepsilon_t$$

$$\ln({}^{YG}/_{PP})_{jt} = -.728d_1 - .805d_2 - .800d_3 + .09\ln\Delta P \qquad (8)$$

$$(j = EP, SX, RN)$$

$$\bar{R}^2 = .99 \qquad DW = 2.4$$

The variables d_1, d_2, d_3 were dummy variables, indicating the appropriate province (d_1 = East Prussia; d_2 = Saxony; d_3 = the Rhineland)[12]. The coefficient was .09 of *equation (8)*, indicating that for a 1% growth in total population, the proportion of young people (<15) would increase by >1%. This result is in accordance with our previous findings in the first section of this paper.

The ramifications of this analysis in terms of the general development of the Prussian economy in the early 19th century are considerable, although it should be noted that the theoretical implications need to be more rigorously tested on the basis of further data. The independent shift in the age structure of the Prussian population, as a direct function of population growth, although lagged behind the registered growth in total population, implied a significant increase in the economically active age group. Furthermore this was particularly noticeable in those regions of Prussia, such as the eastern provinces, where birth rates throughout this period were relatively high. In East and West Prussia, for example, the

11 Pitchford, J.D., *Population in Economic Growth*, North Holland 1974, pp. 13–18.
12 Coale, A.J. (Ed.), I.E.A., *Economic Factors in Population Growth*, London 1976.

proportion of women between 14 and 45 years to total population rose markedly in the 1840's (*Table 4*). In Prussia as a whole the proportion of active males between 15 and 45 years of age also increased significantly in the period 1816 to 1837 from 21.72% of total population to 23.91%. This independent shift in population age structure, as a direct function of population growth, would also have had important repercussions on the Prussian economy, by affecting overall labour supply and arguably the average level of money wages.

Table 4

The number of women between 14 and 45 years of age in East and West Prussia, expressed as a proportion of total population (1816-1852).

Census Year	Number of Women (14-45 years)	Total Population	%
1816	343,872	1,457,255	23.59
1819	380,349	1,638,620	23.21
1822	397,608	1,795,510	22.10
1825	416,748	1,914,725	21.76
1828	430,673	2,008,361	21.44
1831	443,326	2,025,927	21.88
1834	466,049	2,071,347	22.49
1837	503,685	2,152,873	23.39
1840	565,532	2,310,172	24.48
1843	589,840	2,405,699	24.51
1846	607,493	2,499,413	24.30
1849	613,977	2,487,293	24.68
1852	644,133	2,604,748	24.72

(A.Frhr.v.Fircks. Rückblick auf die Bewegung der Bevölkerung im preussischen Staate. Preussische Statistik, XLVIII A. Berlin, 1879, Table XIV.)

At a further level it could also be argued that a rapid growth of the labour force also provided an economic benefit, by facilitating an adjustment to technological change, provided it is accepted that new entrants to the labour force benefited from an easier adaptation to new techniques of production. Equally a relatively younger population should theoretically have been more mobile.

However, it is clear that a more appropriate analysis of this particular issue ought to include output per head in each province under consideration, in order to take into account regional differences both in income and in life expectancy (*Equation 5*). Nevertheless despite the absence of data on regional income differences, particularly for the first half of the 19th century, the results obtained from this analysis have a very high explanatory power (90%).

F. Conclusion

Despite the preliminary nature of this analysis, certain results can be advanced. It is important to note in the first instance that the rate of growth of population in Prussia during the period under consideration (1816–1873) had no significant effect on other economic variables, particularly as far as the growth of agricultural output and the supply of arable land was concerned. Equally the traditional Malthusian hypothesis does not fit the available data, and it could indeed be argued that the Marxist hypothesis emphasising the absence of any significant effect attributable to population growth, is more appropriate as far as the case of Prussia was concerned. No time trend can be fitted to the rate of growth of population in Prussia, which serves again to emphasise its inherent independence of trended economic variables and the extent to which a narrowly Malthusian and endogenous explanation of the pattern of population growth fails to fit the available data.

The impact of population growth on economic variables, on the basis of this analysis, was minimal. As far as the primary sector was concerned (and this remained the major sector within the Prussian economy throughout the first half of the 19th century), a high proportion of the growth in output during the immediate period under consideration was directly attributable to increased land productivity, rather than the rate of growth of population. It is also worth noting that in those provinces of Prussia increasingly affected by nascent industrialisation (specifically the Rhineland and Saxony), price and market signals appear to have been more powerful than in East Prussia, with its continuing agrarian base.

Finally the results of the present analysis provide little, if any, evidence of a direct relationship between demographic fluctuations and cyclical economic trends. Although it is generally recognised that data deficiencies make such an analysis particularly for the first half of the 19th century dependent largely on conjecture, it would appear that demographic fluctuations, despite their short-term intensity, did not impinge substantially on the pattern of cyclical development within the Prussian economy as a whole. This analysis, therefore, can be regarded as providing confirmation of earlier studies, which postulated only a limited degree of correlation between demographic and economic indices in 19th century Germany[13].

13 However Appendix B does provide an equation which attempts to incorporate a dynamic role to the population variable, on the assumption that this type of relationship did exist. It must be emphasised, however, that the extant data utilised in this analysis, provide no confirmation of such a role as originally postulated by Lösch. The economic cycles to be found in Prussia from the 1840's onwards conform to the typology of general business cycles, typical of a developing capitalist economy and are not related in any positive sense to the growth rate of total population.

Additional References Utilised:

a Griesmeier, Josef, *Die Entwicklung der Wirtschaft und der Bevölkerung von Baden und Württemberg im 19. und 20. Jahrhundert*, in: Jahrbücher für Baden-Württemberg, 1 (1954), p. 125 ff.

b Lee, William Robert *Primary Sector Output and Mortality Change in early 19th Century Bavaria*, in: The Journal of European Economic History, 6 (1977), pp. 133–162.

c Rabinovitz, P. M., *Influence of Economic Cycles on the Movement of Population*, in: *Proceedings of the World Population Conference, Bd. 4, New York 1967.*

d Spree, Reinhard, *Wachstumstrends und Konjunkturzyklen in der deutschen Wirtschaft von 1820 bis 1913*, Göttingen 1978, S. 115–138.

It is important to emphasis again, however, that these results are purely preliminary. Indeed a more rigorous testing of the hypotheses incorporated in this analysis must in any case depend on a greater availability of data, particularly relating to wages, rents and distribution. The availability of such material will, in turn, depend on further archival work designed to assemble the necessary long-run series. Indeed the incorporation of the population variable into economic growth models still remains in a general sense rather primitive and controversial, simply because of the continued absence of empirical facts. Without these facts it is invariably difficult to determine the critical interaction or even the magnitude of the relationship between economic and demographic variables. Nevertheless it is to be hoped that the present analysis has gone some way towards clarifying the interrelationship between demographic and economic variables in the development of Prussia during the period 1816 to 1873, and has at the same time contributed to some extent to the more general discussion of the role of population growth in economic theory.

Zusammenfassung: Demographische Fluktuationen und ökonomische Entwicklung in Preußen, 1816–1873

Die Rolle der Variablen Bevölkerung im Rahmen des Wirtschaftswachstums Deutschlands im 19. Jahrhundert ist immer noch umstritten. Einerseits wird das Bevölkerungswachstum im Laufe dieses Zeitraumes als eine Folge des gesteigerten Outputs sowohl in der Landwirtschaft als auch in den entstehenden Industriezentren betrachtet. Diese Meinung wird von verschiedenen Autoren vertreten (z. B. von Ipsen, Köllmann und von Nell), die die Auswirkung der Preußischen Bauernbefreiung und des nachfolgenden Landesausbaus auf die Produktivität der einheimischen Landwirtschaft stark betonen. Andererseits gibt es Forscher, die die exogene Rolle der Variablen Bevölkerung verteidigen. Lösch hat z. B. während der 1930er Jahre sogar behauptet, daß Veränderungen in der Wachstumsrate der Bevölkerung als eine der Hauptursachen für wirtschaftliche Konjunkturen anzusehen wären.

Die Absicht dieses Aufsatzes besteht darin, die demographische Entwicklung in Preußen im Zeitabschnitt 1816 bis 1873 zu analysieren, besonders hinsichtlich des möglichen Einflußes der gegebenen Bevölkerungsschwankungen auf die Wachstumsrate des landwirtschaftlichen Outputs und auf die Struktur des primären Sektors. Gebrauch wird gemacht von vorhandenem statistischem Material über die Bewegung der Bevölkerung in Preußen (von Fircks), über Input und Output in der Landwirtschaft (H. W., Graf Finck von Finckenstein) und über relevante Preise (Jacobs und Richter).

Der Aufsatz gliedert sich in vier Teile:

(a) Eine Analyse des Problems, inwiefern das Bevölkerungswachstum in Preußen die Ausdehnung der landwirtschaftlichen Nutzfläche und die Struktur des Outputs im primären Sektor beeinflußt hat.

(b) Ein Versuch, die endogene bzw. exogene Rolle des Bevölkerungswachstums zu bestimmen.

(c) Eine vorläufige Analyse des Zusammenhangs zwischen Bevölkerungswachstum einerseits, der Altersstruktur der inländischen Bevölkerung andererseits.

(d) Schließlich wird ein Versuch unternommen, die Ergebnisse dieser Untersuchungen im Rahmen der Wachstumszyklen der preußischen Wirtschaft während dieses Zeitraums zu analysieren.

Zu den Ergebnissen:

Erstens haben wir versucht, die gegebenen Trends der Fertilität und der Mortalität in Preußen zu erklären. Die Ergebnisse dieser Analyse zeigen, daß eine Zunahme der Geburtenrate die allgemeine Wachstumsrate der Bevölkerung positiv beeinflußt hat. Schwankungen der Sterberate haben das allgemeine Bevölkerungswachstum viel weniger beeinflußt.

Zweitens: Um überhaupt die Faktorproduktivitäten in der preußischen Landwirtschaft während dieses Zeitraums analysieren zu können, sind wir von folgender Hypothese ausgegangen: Bei gegebener Wachstumsrate der Bevölkerung muß der Kapitalinput in der Landwirtschaft erhöht werden, wenn die Arbeitsproduktivität konstant bleiben soll. Unsere Ergebnisse zeigen, daß zwischen 1816 und 1873 die Bodenproduktivität tatsächlich angestiegen ist. Demgegenüber hat die Arbeitsproduktivität viel langsamer zugenommen.

Drittens haben wir versucht, den Einfluß des Bevölkerungswachstums auf die Ausdehnung der landwirtschaftlichen Nutzfläche und die Struktur des Outputs im primären Sektor zu ermitteln. Dabei wurden weitere Aspekte dieses Problems berücksichtigt, z. B. die mögliche Auswirkung des Bevölkerungswachstums auf das relative Ausmaß des Anbaus von Getreide und Kartoffeln sowie die damit zusammenhängenden Veränderungen in der Struktur des landwirtschaftlichen Outputs (gekennzeichnet durch einen Wechsel in der durchschnittlichen Zusammensetzung der Nahrung – Kost – der Bevölkerung). Diese Probleme wurden auch auf disaggregierter Basis untersucht in bezug auf drei preußische Provinzen (Ost-Preußen, das Rheinland und Sachsen). Die Ergebnisse zeigen im allgemeinen, daß ein Wachstum der Bodenproduktivität viel eher durch die Einführung von landwirtschaftlichen Reformen und durch eine wirksamere Benutzung der gegebenen einfachen Technologie erzielt wurde als durch das Wachstum der preußischen Bevölkerung. Das Bevölkerungswachstum, in diesem Zusammenhang eine exogene Variable, hat nur wenig zur Erhöhung der Bodenproduktivität in den drei Provinzen beigetragen.

Viertens: Als Konsequenz der vorherigen Analyse wurde ein Versuch gemacht, die Malthusianische Theorie (d. h. die postulierte Abhängigkeit des Bevölkerungswachstums von wirtschaftlichen Variablen) zu testen. Die Ergebnisse zeigen, daß es keine enge Korrelation zwischen Angebotsvariablen und dem Bevölkerungswachstum gegeben hat. Es ist allerdings klar, daß weitere Forschungsarbeiten notwendig sind, um die sozialen, wirtschaftlichen und politischen Faktoren, die die Veränderung der Fertilität beeinflußt haben, richtig und präzis bestimmen zu können.

Fünftens haben wir versucht, den Zusammenhang zwischen Veränderungen des Bevölkerungswachstums und der Struktur der Bevölkerung zu analysieren. Die Ergebnisse zeigen, daß die Altersstruktur der inländischen Bevölkerung grundsätzlich durch die Wachstumsrate beeinflußt wurde.

Obwohl die Ergebnisse dieser Analyse als vorläufig zu betrachten sind, ist zu betonen, daß die Wachstumsrate der preußischen Bevölkerung während des Zeitraums 1816 bis 1873 keinen signifikanten Einfluß auf wirtschaftliche Variablen (besonders nicht auf das Wachstum der Landwirtschaft und der landwirtschaftlichen Nutzfläche) gehabt hat. Andererseits ist zweifelhaft, ob das herkömmliche endogene Malthusianische Modell überhaupt in der Lage ist, die Mechanismen des Bevölkerungswachstums in Preußen zu erklären. Jedenfalls war die Wirkung des Bevölkerungswachstums auf die Entwicklung der Landwirtschaft in diesem Zeitraum nicht bedeutend. Andere Variablen, z. B. die erhöhte Bodenproduktivität, waren in diesem Zusammenhang ausschlaggebend. Weitere Forschungen sind natürlich erwünscht, um die problematische Verkettung von Bevölkerungswachstum und wirtschaftlicher Entwicklung in Preußen während des 19. Jahrhunderts zu erklären. Wir hoffen jedoch, daß diese Studie einen sinnvollen Beitrag zur laufenden Diskussion zu leisten vermag.

Appendix A: Notation

PP	= Total population
t	= Time trend
ΔP	= Rate of growth of population
TB	= Total births
TD	= Total deaths
Y	= Total agricultural output
N	= Total employment
L	= Total land under cultivation
LL	= Log of land input
i	= grain (INLG), vegetable crops (INLH), fodder crops (INLF)
P	= price index of agricultural goods
OUTPOT	= potato output
OUTGR	= grain output
YG	= population under 15 years of age

Appendix B: The relation between the path of agricultural output and population growth

Let the rate of growth of population (Δp) follow an AR2 process of the following form:

$$\Delta p = a_1 + a_2 \Delta p_{-1} + a_3 \Delta p_{-2},$$

the general solution of the second order difference equation is:

$$\Delta p = A_1 (b_1)^t + A_2 (b_2)^t$$

and the particular solution is:

$$\Delta p = \frac{a_1}{1 - a_2 - a_3} \quad \text{for} \quad a_2 + a_3 \neq 1$$

The stability conditions are

$$|b_1| < 1, \; |b_2| < 1.$$

The total solution of the equation is:

$$\Delta p = \frac{a_1}{1 - a_2 - a_3} + A_1(b_1)^t + A_2(b_2)^t$$

Assuming that Δp is related to Y^* via the following equation

$$Y_t = a_4 + a_5 \Delta p + a_6 Y_{t-1}.$$

The path of Y_t will be influenced by the path of Δp in the following way: the general solution for Y_t is

$$Y_t = A_3(b_3)^t \qquad \text{(for stability } |b_3| < 1)$$

and the particular solution is

$$Y_t = E + J(b_1)^t + H(b_2)^t$$

where

$$E = \frac{a_4 - \dfrac{a_1}{1 - a_2 - a_3}}{1 - a_6}$$

$$J = \frac{A_1}{1 - \dfrac{1}{b_1}}$$

$$H = \frac{A_2}{1 - \dfrac{1}{b_2}}$$

So the total solutions of the Y_t equilibrium will be

$$Y_t = \frac{a_4 + \dfrac{a_1}{1 - a_2 - a_3}}{1 - a_6} + \frac{A_1}{1 - \dfrac{1}{b_1}}(b_1)^t + \frac{A_2}{1 - \dfrac{1}{b_2}}(b_2)^t + A_{3(b_3)}t$$

So the path of Y_t is directly affected by the path of Δp_t since the roots of the Δp polynominal (b_1, b_2) appear explicitly in the particular solution of Y_t, determining its path.

* agricultural output.